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GRADED MOBILIZATION VERSUS SHORTWAVE DIATHERMY WITH STRETCHING FOR PAIN AND RANGE OF MOTION IN ADHESIVE CAPSULITIS

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Abstract

Background: Adhesive capsulitis causes painful progressive restriction of shoulder movement. Both joint mobilization and deep-heating modalities + stretching are used; direct comparisons are limited. Objective: To compare the effect of graded (high-grade/end-range) mobilization + stretching versus shortwave diathermy (SWD) + stretching in stage-II adhesive capsulitis.

Methods: Experimental randomized allocation of 60 subjects (30 per group). Group A: graded mobilization + stretching. Group B: SWD (27.12 MHz, contraplanar pads, 20 min) + stretching. Outcomes: Visual Analogue Scale (VAS), active/passive ROM (flexion, abduction, external/internal rotation) by goniometer, and Shoulder Pain and Disability Index (SPADI). Assessments: baseline and after 4 weeks. Statistics: paired t / Wilcoxon (within-group), unpaired t / Mann-Whitney U (between-groups); SPSS v16.

Results: Both groups improved significantly from baseline on VAS, ROM and SPADI (within-group $p<0.001$). Between-group comparisons showed greater gains for the mobilization group in abduction (post-treatment $p=0.0309$; difference $p=0.0120$) and external rotation (post $p=0.0172$; difference $p=0.0002$). VAS between-group differences were not statistically significant (pre $p=0.3077$; post $p=0.0604$; diff $p=0.2226$). SPADI had baseline and post differences (pre $p=0.0045$; post $p=0.0064$) but the change (difference) between groups was not significant ($p=0.7938$).

Conclusion: Both interventions reduced pain and improved ROM and function; graded mobilization + stretching produced significantly greater improvements in shoulder abduction and external rotation compared with SWD + stretching.

Keywords: adhesive capsulitis; joint mobilization; shortwave diathermy; SPADI; randomized.

Introduction

Adhesive capsulitis, also known as frozen shoulder, is a common clinical condition characterized by the insidious onset of shoulder pain associated with progressive limitation of both active and passive glenohumeral joint movements. Codman first described the condition as "difficult to define, difficult to treat, and difficult to explain," reflecting the complexity of its presentation and management[1]. The condition is often divided into primary (idiopathic) and secondary forms. Primary adhesive capsulitis develops without an identifiable cause, while secondary adhesive capsulitis arises following trauma, surgery, immobilization, or systemic conditions such as diabetes mellitus and thyroid dysfunction[5].

Epidemiological studies suggest that adhesive capsulitis affects between 2% and 5% of the general population, with a higher prevalence reported in individuals with diabetes, ranging from 10% in type I diabetes to up to 22% in type II diabetes[5]. The condition is more common in women and typically affects individuals aged between 40 and 60 years[14]. Although adhesive capsulitis is often considered self-limiting, resolution may take 1–3 years, and some patients experience persistent restriction and disability if untreated. This prolonged course can substantially impact daily living, occupational activities, and quality of life.

The pathophysiology of adhesive capsulitis remains incompletely understood. Histological studies have demonstrated capsular fibrosis, contracture of the rotator interval, and chronic inflammatory changes resembling Dupuytren's disease[6]. Cytokine-mediated processes are believed to play a role, with increased deposition of collagen and fibroblastic proliferation contributing to capsular thickening and contracture[6]. Clinically, patients progress through three overlapping stages: the painful "freezing" stage, the stiff "frozen" stage, and the "thawing" stage characterized by gradual resolution of symptoms[9]. The hallmark finding is a capsular pattern of motion restriction, with external rotation most severely affected, followed by abduction and internal rotation[14].

Several therapeutic strategies have been proposed for the management of adhesive capsulitis. These include pharmacological interventions such as non-steroidal anti-inflammatory drugs and corticosteroid injections, invasive procedures such as distension arthrography, manipulation under anesthesia, and arthroscopic capsular release, as well as conservative physical therapy-based interventions[9],[10]. Conservative management remains the mainstay of treatment, particularly in the frozen stage, where pain subsides but significant stiffness persists.

Among physiotherapeutic modalities, stretching and mobilization techniques are widely applied to improve capsular extensibility and restore joint kinematics. Mobilization involves passive, skilled, and repetitive movements applied to joints and periarticular tissues. The biomechanical rationale is to stretch shortened capsuloligamentous tissues, while the neurophysiological rationale includes stimulation of joint mechanoreceptors and inhibition of nociceptors, leading to pain reduction and improved mobility[17]. High-grade mobilization techniques applied at end ranges of motion are particularly advocated in adhesive capsulitis, with randomized controlled trials reporting superior improvements in range of motion compared with low-grade techniques[19].

In addition to manual therapy, thermal modalities are commonly employed as adjuncts in adhesive capsulitis management. Shortwave diathermy (SWD) is a deep heating modality that applies high-frequency electromagnetic energy to generate heat within tissues. The thermal effect of SWD has been shown to alter the viscoelastic properties of periarticular structures, thereby enhancing tissue extensibility and facilitating stretching[15]. Compared with superficial heating agents such as hot packs, SWD penetrates deeper tissues and can heat larger treatment areas, making it particularly suitable for periarticular shoulder structures[16]. Clinical studies suggest that combining SWD with stretching exercises can improve pain relief and functional outcomes[16].

Despite the widespread use of both mobilization and SWD, comparative evidence evaluating their relative effectiveness when combined with stretching is limited. Some studies support mobilization as an effective strategy to enhance mobility and function in adhesive capsulitis[17],[19], while others highlight the benefits of SWD in improving tissue extensibility and facilitating rehabilitation[15],[16]. However, head-to-head trials assessing whether mobilization confers superior benefits compared to SWD, or vice versa, remain scarce.

Given the lack of conclusive evidence, a direct comparison of these two approaches is warranted. In clinical practice, stage II adhesive capsulitis presents as a particularly disabling phase, characterized by marked stiffness and limited pain. This phase is often considered optimal for interventions targeting mobility restoration. Thus, comparing the effectiveness of graded mobilization versus SWD,

each combined with stretching, can provide important insights into their relative therapeutic value and guide evidence-based physiotherapy practice.
The present study was therefore designed to evaluate and compare the effectiveness of graded mobilization with stretching against shortwave diathermy with stretching in improving pain, shoulder range of motion, and functional disability in patients with stage II adhesive capsulitis.

Objectives

1. To determine the effectiveness of graded mobilization combined with stretching in subjects with stage II adhesive capsulitis.
2. To determine the effectiveness of shortwave diathermy combined with stretching in subjects with stage II adhesive capsulitis.
3. To compare the relative effectiveness of graded mobilization with stretching versus shortwave diathermy with stretching on pain, range of motion, and functional outcomes in subjects with stage II adhesive capsulitis.

Materials and Methods

Study Design and Setting

This study adopted an experimental design with random allocation of participants into two treatment groups. The research was conducted at the Department of Physiotherapy, S.D.M. College of Medical Sciences and Hospital, Dharwad, after obtaining ethical clearance from the institutional ethics committee.

Participants

A total of 60 participants diagnosed with stage II adhesive capsulitis of the shoulder were recruited. Subjects were referred by orthopedic consultants and screened for eligibility based on inclusion and exclusion criteria. Stage II adhesive capsulitis was defined clinically as the presence of shoulder pain and significant limitation of active and passive range of motion, with external rotation being the most restricted movement and pain occurring primarily at end ranges, consistent with previously established diagnostic criteria[14].

Inclusion criteria

- Age between 40 and 60 years.
- Either gender.
- Clinical diagnosis of stage II adhesive capsulitis.

Exclusion criteria

- Contraindications to high-grade mobilization, such as malignancy, recent fractures, hypermobility, or active inflammation.
- Contraindications to stretching, including bony blocks limiting joint motion, hematoma, or recent fracture.
- Contraindications to shortwave diathermy, such as metallic implants, hemorrhage, thrombosis, arterial diseases, tumors, or disturbed skin sensations.

All eligible participants provided informed consent before enrollment. Demographic information, symptom duration, and occupational history were recorded at baseline.

Sample Size

The sample size was calculated through a pilot study using the formula for comparing two means, with power set at 80% and significance at 5%. Based on the calculation, 60 subjects were recruited and randomly allocated equally into two groups (n=30 each).

Randomization and Allocation

Randomization was performed using sealed, opaque envelopes containing group assignments labeled "A" (mobilization with stretching) or "B" (shortwave diathermy with stretching). The principal investigator allocated participants by sequentially opening envelopes. This ensured concealment of allocation and minimized selection bias.

Interventions

Group A: Graded Mobilization with Stretching

Participants in Group A received high-grade glenohumeral mobilization techniques (Maitland grades III and IV), combined with stretching exercises.

- Mobilization techniques: Inferior glide, posterior glide, and anterior glide mobilizations were applied at end ranges of motion. Grade III involved large-amplitude rhythmic oscillations into tissue resistance, while Grade IV consisted of small-amplitude oscillations at end range. Each mobilization was performed at a frequency of 2–3 oscillations per second for 1–2 minutes, with treatment duration of approximately 30 minutes per session.
- Stretching: Passive stretching included external rotation, forward elevation, horizontal adduction, and internal rotation (hand-behind-back). Each stretch was performed for 30 seconds with 10 seconds of rest, repeated four times. Intensity was limited to tolerable discomfort. Patients were instructed to perform these stretches daily at home.
- Codman's exercises: Patients were taught to perform pendular exercises in multiple planes to facilitate relaxation and mobility, as adjunct home exercises[20].

Group B: Shortwave Diathermy with Stretching

Participants in Group B received shortwave diathermy (SWD) followed by the same stretching and Codman's exercises as Group A.

- SWD parameters: A capacitor field method was applied using a 250 W SWD unit operating at 27.12 MHz frequency. Electrodes were placed in a contraplanar arrangement over the anterior and posterior aspects of the shoulder joint. The intensity was adjusted until subjects reported a comfortable sensation of warmth. Each treatment lasted 20 minutes[15,16,33].
- Stretching and exercises: The same stretching protocol and Codman's exercises described for Group A were administered immediately after SWD.

Both groups received treatment sessions over a four-week period. Compliance with home exercise programs was reinforced at each visit.

Outcome Measures

All assessments were performed at baseline and after four weeks of intervention.

1. Pain: Measured using the Visual Analogue Scale (VAS), a 10 cm horizontal line anchored with "no pain" at one end and "worst pain imaginable" at the other. VAS has been validated as a reliable measure of both acute and chronic pain[25,26].
2. Range of Motion (ROM): Active shoulder flexion, abduction, external rotation, and internal rotation were assessed using a universal goniometer, a reliable tool for measuring shoulder mobility[27].
3. Functional Disability: The Shoulder Pain and Disability Index (SPADI), a validated self-administered questionnaire with two domains (pain and disability), was used to assess functional limitations[28].

Statistical Analysis

Statistical analysis was performed using SPSS version 16. Descriptive statistics (mean ± standard deviation) were calculated for all variables. Within-group comparisons of pre- and post-treatment scores were analyzed using paired t-tests for parametric data and Wilcoxon matched pairs test for

VAS scores. Between-group comparisons were analyzed using unpaired t-tests for ROM and SPADI, and the Mann–Whitney U test for VAS scores. A p-value of <0.05 was considered statistically significant.

Results

A total of 60 participants were enrolled and randomized equally into two groups (n=30 in each). Both groups were comparable at baseline with respect to age, gender distribution, and occupation (Table 1). The mean age of participants was 55.7 ± 4.8 years in the mobilization group and 53.4 ± 5.2 years in the SWD group.

Pain (VAS)

Within-group analysis demonstrated significant reduction in VAS scores in both groups after four weeks ($p < 0.001$). The mobilization group showed a mean reduction of 1.77 ± 1.07, whereas the SWD group showed a mean reduction of 1.37 ± 1.35. Between-group comparison revealed no statistically significant difference in VAS change scores ($p = 0.22$) (Table 2, Figure 1).

Functional Disability (SPADI)

Both groups showed significant improvements in SPADI scores post-intervention ($p < 0.001$). The mobilization group improved by 6.28 ± 3.48 points, while the SWD group improved by 6.59 ± 5.55 points. Between-group differences in mean change were not statistically significant ($p = 0.79$). However, baseline SPADI scores were higher in the SWD group, and post-intervention values also remained higher in this group (Table 2, Figure 2).

Range of Motion (ROM)

Both groups demonstrated significant gains in shoulder ROM across all measured movements (flexion, abduction, external rotation, internal rotation) ($p < 0.001$ within groups). Between-group analysis revealed that mobilization with stretching produced significantly greater improvements in abduction ($p = 0.012$) and external rotation ($p = 0.0002$) compared to SWD with stretching. No significant between-group differences were observed for flexion or internal rotation (Table 3, Figure 3).

Table 1. Baseline characteristics of participants

Variable	Mobilization (n=30)	SWD (n=30)
Male / Female	15 / 15	16 / 14
Mean age (years ± SD)	55.73 ± 4.83	53.40 ± 5.23

Table 2. Pain (VAS) and functional disability (SPADI) outcomes

Outcome	Group	Pre mean ± SD	Post mean ± SD	Mean change ± SD	p-value (within)	p-value (between change)
VAS	Mobilization	7.27 ± 1.34	5.50 ± 1.53	1.77 ± 1.07	<0.001	
VAS	SWD	7.67 ± 1.60	6.30 ± 1.58	1.37 ± 1.35	<0.001	0.22
SPADI	Mobilization	33.95 ± 11.82	27.68 ± 11.29	6.28 ± 3.48	<0.001	
SPADI	SWD	41.93 ± 8.88	35.34 ± 9.60	6.59 ± 5.55	<0.001	0.79

Table 3. Shoulder ROM outcomes (degrees)

Movement	Group	Pre mean ± SD	Post mean ± SD	Change mean ± SD	p-value (between change)
Flexion	Mobilization	120.33 ± 24.70	135.00 ± 23.67	14.67 ± 11.81	0.27
Flexion	SWD	117.33 ± 16.33	128.67 ± 15.81	11.33 ± 11.14	
Abduction	Mobilization	85.83 ± 29.45	106.00 ± 29.69	20.17 ± 15.67	0.012
Abduction	SWD	80.17 ± 22.07	91.00 ± 22.30	10.83 ± 11.97	
External rotation	Mobilization	30.33 ± 19.52	43.33 ± 20.94	13.00 ± 9.34	0.0002
External rotation	SWD	26.67 ± 14.16	31.83 ± 14.88	5.17 ± 5.80	
Internal rotation	Mobilization	39.83 ± 17.49	49.83 ± 16.79	10.00 ± 7.66	0.12
Internal rotation	SWD	47.33 ± 19.15	53.83 ± 18.79	6.50 ± 9.57	

Figure 1. Comparison of mean reduction in VAS scores between mobilization and SWD groups after 4 weeks.

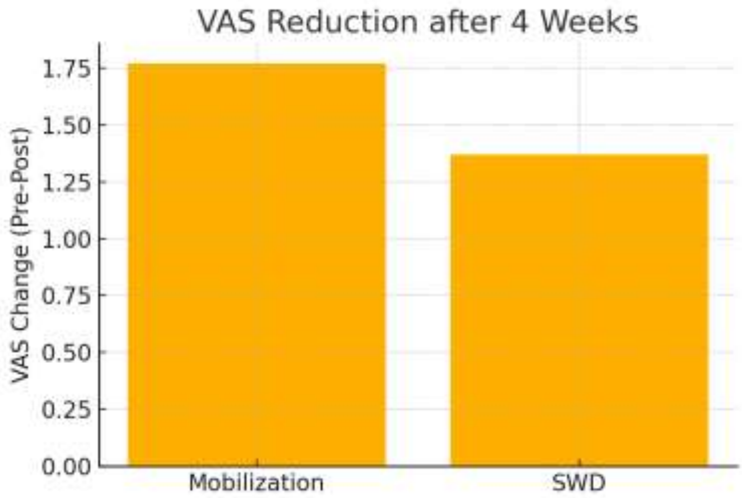


Figure 2. Comparison of SPADI improvement (pre–post change) between mobilization and SWD groups after 4 weeks.

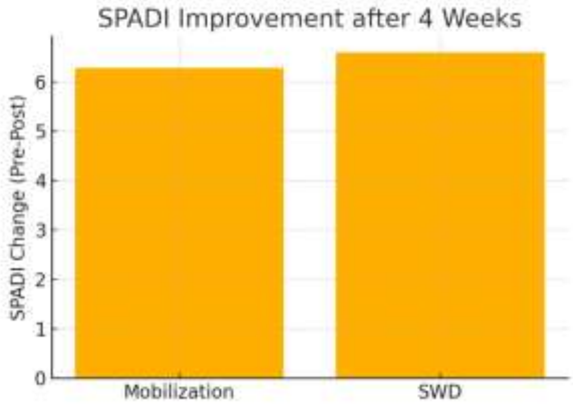
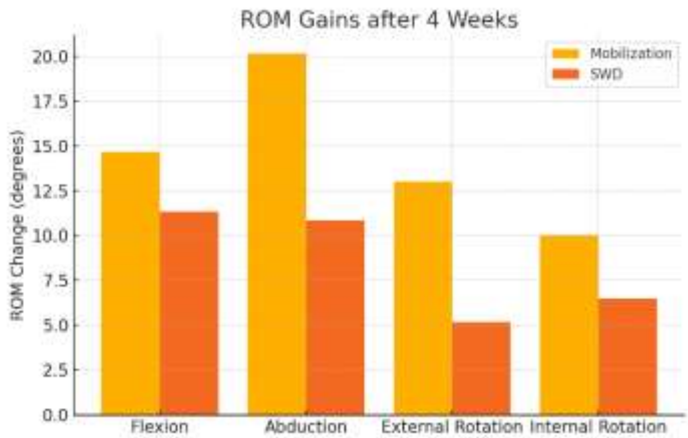


Figure 3. Mean improvements in shoulder ROM (flexion, abduction, external rotation, internal rotation) in mobilization and SWD groups after 4 weeks. Mobilization showed significantly greater gains in abduction and external rotation.



Discussion

The present study compared the effectiveness of graded mobilization with stretching and shortwave diathermy (SWD) with stretching in subjects with stage II adhesive capsulitis. Both interventions resulted in statistically significant improvements in pain, range of motion (ROM), and functional disability after four weeks of treatment. However, graded mobilization with stretching produced significantly greater gains in shoulder abduction and external rotation compared to SWD with stretching, while improvements in pain (VAS) and functional disability (SPADI) were comparable between the two groups.

The finding that both interventions significantly reduced pain is consistent with earlier reports emphasizing the benefits of physiotherapeutic interventions in adhesive capsulitis. Joint mobilization has been shown to alleviate pain through stimulation of mechanoreceptors and inhibition of nociceptors, thereby modulating nociceptive input at the spinal level[17,31]. Similarly, SWD is known to provide analgesic effects by elevating tissue temperature, improving blood flow, and promoting relaxation of periarticular tissues[15]. Previous studies have also reported significant reductions in pain with both mobilization and electrotherapeutic modalities, supporting the results of the present trial[16].

Functional disability, as measured by SPADI, improved significantly in both groups, without significant between-group differences in mean change. This suggests that both graded mobilization and SWD, when combined with stretching, are effective in improving activities of daily living and shoulder function. However, it is noteworthy that baseline SPADI scores were higher in the SWD group, and post-treatment scores remained higher, indicating greater residual disability despite comparable change scores. This observation highlights the importance of considering baseline variability when interpreting functional outcomes. Similar findings were reported by Vermeulen et al., who found that both high-grade mobilization and conservative exercise programs improved function, although mobilization yielded superior ROM gains[19].

The most significant finding of this study was the greater improvement in abduction and external rotation observed in the mobilization group compared to the SWD group. External rotation is typically the most restricted motion in adhesive capsulitis and is crucial for tasks such as grooming and overhead activities[14]. Improvements in this domain therefore have direct implications for functional recovery. High-grade mobilization techniques applied at end range likely account for these superior outcomes, as they specifically target capsular tightness and stretch the contracted capsule at its mechanical limit. Vermeulen et al. demonstrated similar results, reporting that high-grade mobilization produced significantly greater improvements in glenohumeral ROM than low-grade techniques[19]. Nicholson also documented beneficial effects of passive joint mobilization in reducing hypomobility associated with adhesive capsulitis[17].

In contrast, SWD, while effective in reducing pain and facilitating stretching, may not provide sufficient mechanical stimulus to overcome capsular contracture. Studies on thermal modalities suggest that while deep heating increases collagen extensibility and facilitates stretching, its effects are maximized when combined with mechanical interventions such as mobilization[15,16]. The present results align with these findings, as SWD with stretching improved ROM but was less effective than mobilization in producing significant gains in abduction and external rotation.

The clinical implications of these findings are noteworthy. In stage II adhesive capsulitis, stiffness rather than pain predominates. Interventions aimed at restoring joint mobility, particularly external rotation and abduction, are therefore crucial. Graded mobilization with stretching should be considered a treatment of choice in such cases, while SWD may be used as an adjunct for pain relief and to facilitate stretching, particularly in patients unable to tolerate mobilization.

Several limitations must be acknowledged. The study followed participants only for four weeks; long-term outcomes and recurrence rates were not assessed. Adherence to the prescribed home exercise program was based on self-report, which may have influenced outcomes. Furthermore, baseline SPADI values differed significantly between groups, which may have introduced bias in functional outcome comparisons. Finally, the study was limited to stage II adhesive capsulitis, and results cannot be generalized to other stages.

Despite these limitations, the present study provides valuable evidence suggesting that graded mobilization with stretching is more effective than SWD with stretching in restoring key ranges of motion in adhesive capsulitis, particularly abduction and external rotation.

Conclusion

Both graded mobilization with stretching and shortwave diathermy with stretching were effective in reducing pain, improving shoulder range of motion, and enhancing functional ability in individuals with stage II adhesive capsulitis over a four-week intervention period. However, graded mobilization with stretching demonstrated superior outcomes in improving abduction and external rotation when compared to shortwave diathermy with stretching. Given that external rotation and abduction are the most restricted and functionally significant movements in adhesive capsulitis, high-grade mobilization should be considered a preferred intervention during the frozen stage. Shortwave diathermy may be employed as an adjunct to stretching for pain relief and to facilitate movement, but mobilization remains the more effective approach for restoring mobility.

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